September 1969 Brief 69-10427

NASA TECH BRIEF

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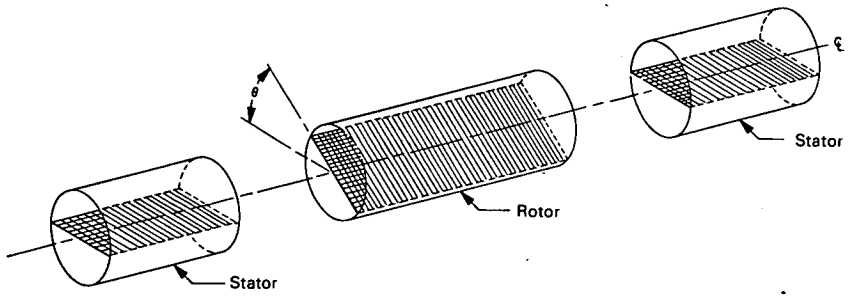
A Compact Rotary Vane Attenuator



The problem:

In the procedure for calibrating microwave receivers, the signal to noise ratio must be determined. An I.F. attenuator introduces a nonlinearity during the calibration procedure due to inaccuracies in the attenuator itself and nonlinearities in the amplifiers.

The solution:

A rotary vane attenuator, when used as a front end attenuator, introduces an insertion loss that is proportional to the angle of rotation. The nonlinearities of the amplifiers no longer affect the results. A technique is developed to allow the construction of a shortened compact unit suitable for use in most installations.

How it's done:

Basically, the rotary vane attenuator consists of three sections of waveguide in tandem. A resistive film is placed across each section of waveguide. The middle section is a short length of circular waveguide which is free to rotate axially with respect to the two fixed end sections; the end sections are rectangular-to-round waveguide transitions in which the resistive films are normal to the field of the applied wave. When all films are aligned, the E field of the applied wave is normal to the films, no current flows and no attenuation occurs. If the center film is rotated to an angle θ the E field is divided into two components: one in the film plane and the other normal to the film. The component in the film plane is completely absorbed while the normal component passes unattenuated to the third section where a similar process takes place. The component that finally emerges is at the same orientation as the original wave and has undergone an attenuation, in decibels, of 40 log cos θ. The attenuation is thus ideally proportional only to the angle at which the center film is rotated and is completely independent of frequency. This simple formula neglects many sources of error and assumes infinite rotor attenuation loss in the E field component in the plane of the film.

A study has been made of vane angle readout errors, misalignment and mismatch errors, phase shift, and vane rotor, attenuation loss. The effects of these sources of error on calibration accuracy have been determined from a detailed error analysis. Classically, the error due to finite rotor loss is minimized by making the rotor very long, the approach used here is

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to shorten the rotor and account for the finite rotor loss with an "exact" theoretical analysis based on a computer program. This method can also be used with any rotary vaned attenuator to improve the accuracy of the simplified formula.

Note:

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Price $3.00
Reference: TSP69-10427

Patent status:

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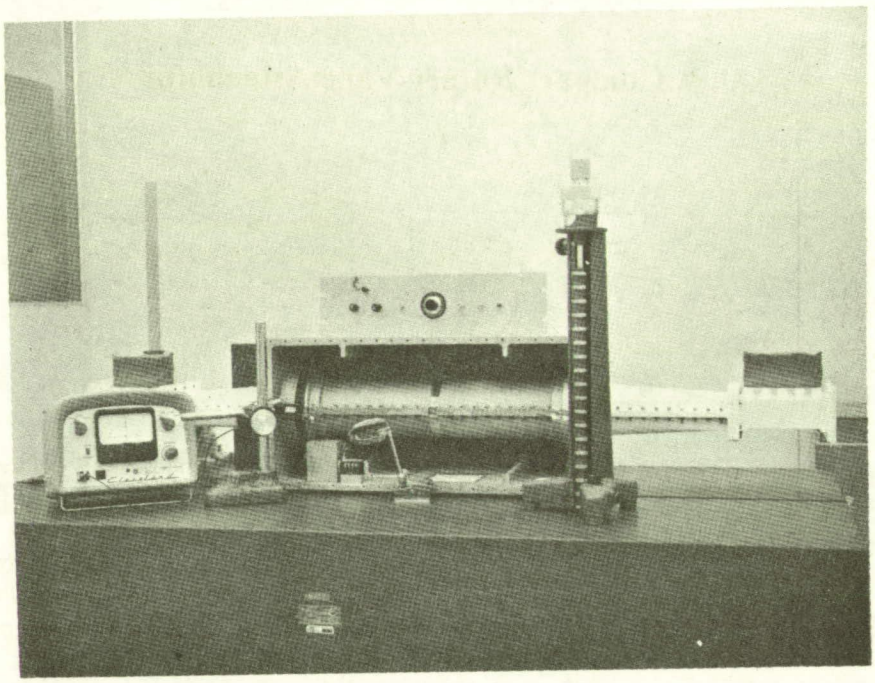
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